DOCUMENT RESUME

ED 082 033 CE 000 331

TITLE	Job Grading Standard for Instrument Maker, WG-4712.
INSTITUTION	Civil Service Commission, Washington, D.C. Bureau of Policies and Standards.
PUB DATE	May 73
NOTE	11p.; FPM Supplement 512-1
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock Number 0600-00699, $0.25)
EDRS PRICE	MF-$0.69 HC-$3.29
DESCRIPTORS	*Government Employees; Government Publications; *Job Analysis; *Labor Standards; Skilled Labor; *Skilled Workers
IDENTIFIERS	*Instrument Maker

ABSTRACT

The standard is used to grade all nonsupervisory jobs involved inplanning and fabricating complex research and prototype instruments, made from a variety of materials, which are used to detect, measure, record, and regulate heat, pressure, speed, vibration, sound, illumination, biomedical phenomena, and other areas of interest to scientific, engineering, or medical personnel. The job is contrasted with that of premium journeyman, and particulars dealing with skill and knowledge, responsibility, physical effort, and working conditions are stated for the WG-14 and WG-15 Instrument Maker positions. (AG)

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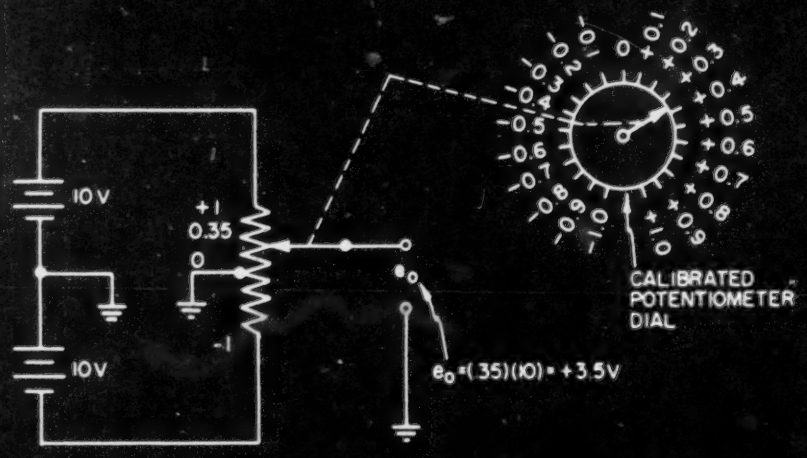
JOB GRADING STANDARD FOR
INSTRUMENT MAKER
WG-4712



U.S. CIVIL SERVICE COMMISSION
BUREAU OF POLICIES AND STANDARDS
TS 23 MAY 1973
FPM SUPPLEMENT 512-1

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COVERAGE OF STANDARD

This standard is used to grade all nonsupervisory jobs involved in planning and fabricating complex research and prototype instruments that are made from a variety of materials and are used to detect, measure, record, and regulate heat, pressure, speed, vibration, sound, illumination, biomedical phenomena, and other areas of interest to scientific, engineering, or medical personnel.

TITLES

Jobs graded by this standard are to be titled *Instrument Maker.*

GRADE LEVELS

This standard describes two levels at which jobs might be established. If jobs differ substantially from the skill, knowledge, and other work requirements described in the grade levels of the standard, they may warrant grading below those grades.

NOTES TO USERS

During the factfinding study for this occupation, certain characteristics were found to be consistent even though agency and installation grading practices differed considerably. These characteristics form the framework of the job grading standard. They are emphasized in this section to assist in identifying the occupation in contrast to other, similar work, and are intended to reinforce the information in the factors as described in the body of the standard.

Most instrument makers were found to be working in organizational units that provided service to research and development activities. Some jobs were found in other shops (for example, machine shops and woodworking shops) that primarily service other functional areas such as manufacturing or maintenance. The jobs in the instrument shops were usually identified as instrument makers at a variety of levels of the Federal Wage System (FWS)

grade structure. Jobs in other shops were usually identified as premium jobs in a single trade (for example, Machinist, WG–12 or 13). While both of these arrangements may be satisfactory for grade level purposes, comparisons are provided to assist in distinguishing the characteristics between the instrument maker jobs in other occupations of the FWS.

Jobs that substantially match the characteristics in column A, below, are instrument makers regardless of the organizational location of the position.

Jobs that substantially match the characteristics in column B, below, are more appropriately considered as premium jobs in a specific trade regardless of their organizational location. These jobs are to be classified by closely comparing them with the grade levels described in the appropriate job grading standard to determine whether they match or exceed the skill and knowledge outlined in the standard and by interpolation between these standards and the one for the instrument maker. These jobs are to be titled to the occupation that includes the single trade work processes.

A INSTRUMENT MAKER	B PREMIUM JOURNEYMAN
1. The work processes used to make the items require the skill and knowledge of more than one specific trade; for example, the worker uses work processes of (a) machining, welding, and metal surface treating; or (b) metal working and electronics. While the worker does not need the skill to perform all the work processes in the broad trade areas, he must have sufficient knowledge of them to establish the requirements for other tradesmen to follow and to accept or reject their work.	1. The work processes used to make the item require skill and knowledge of a single trade; for example, machinist, toolmaker or sheetmetal worker. The worker has the skill to perform all the work processes. On large, multipart projects, he may assign work to other workers in his trade, check their plans, and provide technical advice and assistance on the work processes.
2. The project requires considerable initiative and imagination in extending and modify-	2. The project requires a very high degree of ability in the particular trade to work to

WG–4712

A INSTRUMENT MAKER	B PREMIUM JOURNEYMAN
ing trade work processes and improvising with them in various combinations to manufacture unique items.	critical exactness and precise tolerances. Trade processes are used to the fullest extent or extended beyond that normally expected of a journeyman.
3. Assignments are usually on a project-to-project basis although the worker occasionally may be called on to assist on another project because he possesses expertise in a specific specialty.	3. Assignments are varied. Because they require the use of the fullest extent of the trade work processes, assignments on some projects may be shared with other trade specialists.
4. After original assignment by the supervisor, the employee works with engineering, professional, or technical personnel for the duration of the project. He consults with his supervisor on principally the most complex trade problems and for administrative purposes.	4. Although work orders are usually initiated by engineering, professional, or technical personnel, work processes are usually approved by the supervisor, especially when trade techniques deviate from normal trade practices.
5. The worker is assigned to and is responsible for the end item; the complete instrument or a complex component of the instrument.	5. Although the worker may work closely with the work-order initiator, completed items are usually approved by a supervisor or an inspector before release.
6. When the assignment is to make an instrument component, the component is either a complete item that can operate as a separate unit and is as complex as complete instruments normally assigned to the shop, or the planning and making of it requires a knowledge of the purpose and use of the instrument in which the component is a critical item.	6. When the assignment is to make an instrument component, the component is usually recognized as an integral part that must fit precisely but does not usually require the knowledge of the purpose and use of the complete instrument.

General: The WG–14 Instrument Maker plans, lays out, fabricates, and modifies a variety of one-time research and development devices, specialized laboratory equipment, and precise instruments which are used to detect, measure, record, and regulate such features as heat, pressure, speed, vibration, sound, illumination, biomedical conditions, or similar other areas of interest to research project personnel. The instruments that the WG–14 Instrument Maker plans and fabricates are nonrepetitive or one-of-a-kind in nature. They are associated with a single broad trade category such as mechanical, or photo optics, or electronics; require skill and knowledge in a broad occupational category such as electronics, or metalworking, or wood and plastic working; require precision fits and tolerances, and possess interrelated dimensions, various angles and planes and unusual contours and shapes, or complex and nonstandard circuitry with a wide variety of electronic components.

The WG–14 Instrument Maker independently plans, lays out, constructs, tests, and assembles the complete instrument and has the full technical and mechanical responsibility for the work plan and all work processes whether he personally performs them or is assisted by other craftsmen for particularly demanding or specialized work. Assignments are received from, and completed work is reviewed by, a supervisor as unusual problems arise; through periodic progress reports from the employee, and through discussions with project engineers, medical doctors, or other scientific and professional personnel.

Another example of work at the WG–14 level is an assignment to plan and construct a complete instrument from electronic and electric components, units, and assemblies. For example, the WG–14 Instrument Maker specializing in this kind of work, devises and constructs complex circuitry based on the determination of cable and wave guide size, insulation, fuse requirements, and other similar needs. He plans, lays out, and selects the number, type, and placement of elements such as relays, solenoids, transformers, condensers, tubes, transistors, switches, inductors, and motors. He determines the number and type of components needed to produce the required carrying capacity, torque, power, and other characteristics of the instrument. He assembles units such as indicators, meters, counters, transmitters, receivers, amplifiers, pattern-recording equipment, and servomechanisms. He makes all connections and completes the model by soldering, riveting, screwing,

bolting, or by other similar fastenings. When the components, units, and assemblies are not available from sources of supply, the WG–14 Instrument Maker fabricates or adapts them from other available material. He checks the operation of the instrument using various measuring devices such as oscilloscopes, bridges, capacitance checkers, analyzers, signal generators, wave inductors, and various types of meters. He also checks the operation of the associated mechanical elements or structural features of the completed instrument to insure that it meets all the requirements as established by the work-order initiator.

Most of the instruments the WG–14 Instrument Maker fashions require that he be familiar with the latest production processes to select, cut, fit, and achieve trueness, and to fasten a variety of materials together with allowances for desired movements, bending, expanding, contracting, or oscillating according to design and operational requirements.

Skill and Knowledge: The WG–14 Instrument Maker applies a knowledge of a variety of manufacturing processes and methods during the planning stage of a project in order to discuss the general idea of a desired item with the work-order initiator (medical doctor, scientist, or engineer). He knows how to calculate loads, sizes, dimensional fits, and weights using shop algebraic and trigonometric formulas, and tables. He recommends alternative methods when design characteristics cannot be met by proposed fabrication processes. For example, he suggests changes because of unsuitable or unavailable materials, impractical component placement or alignment, or unrealistic fabrication requirements in the initial design. He considers such factors as shrinkage, warpage, desired life, location of component members, surface finish, atmospheric, oceanographic, medical, or biological environment, pressure, heat, stresses, and strain. From the nature of the intended use of the instrument, he must be able to determine what materials and work methods to use and the operational and fabrication process to follow.

The WG–14 Instrument Maker knows how to plan and lay out complete instruments, assemblies, and subassemblies, to reproduce scale designs, and to plan work sequences so that other employees assigned to make parts of the product can easily follow instructions. He uses skill and a broad knowledge of related and allied

trades. For example, he may be skilled in setting up and operating a variety of metalworking machines or woodworking and plastic-working machines and apparatus to make items with hard to define reference points and three-dimensional configurations.

The WG–14 Instrument Maker must know how to develop and fabricate special tools, fixtures, and jigs to hold, machine, fabricate, and assemble items with compound curves and intersecting compound angles. In addition, he must be skilled in using a variety of precise measuring devices such as supermicrometers and shadowgraphs and a variety of specialized tools and equipment such as electrical discharge machines, jewelers lathes, microsoldering and welding equipment, or oscilloscopes, bridges, capacitance checkers, analyzers, signal generators, wave indicators, and various other similar types of meters.

Responsibility: The supervisor, doctor, or designer makes general assignments without detailed instructions. The WG–14 Instrument Maker receives work orders and instructions in terms of the intended use, operational characteristics, approximate configuration, size, weight, dimensions, tolerances, and the number and kind of assemblies and subassemblies. The guidelines provided consist mainly of drawings, photographs, sketches, and oral information related to basic design data without specific details of component placement and relationships, sizes, fits, shapes, or materials (such specific details are developed during the fabrication processes). The researcher depends on the originality and ingenuity of the employee for the solution of fabrication, assembly, installation, and related problems. There are few guidelines or precedents and the WG–14 Instrument Maker exercises considerable judgment in selecting or rejecting materials, work processes, and fabrication techniques.

The WG–14 Instrument Maker personally performs all the fabrication and assembly operations, or he personally performs the most complex work and assumes the responsibility for the complete assignment by guiding and coordinating the effort of other workers on large and multipart instruments. He consults with the supervisor principally on problems such as obtaining required equipment, materials, and manpower. The supervisor reviews the work on only the most complex, technical problems and through discussions with technical and professional personnel with whom the instrument maker is working.

Physical Effort: The WG–14 Instrument Maker frequently handles objects weighing up to 10 pounds, and occasionally, at various stages of some assignments, he may assemble heavy items up to 50 pounds without the assistance of lifting devices. The work involves standing, walking, stooping, bending, kneeling, climbing up and down ladders, and scaffolding, and pulling and pushing.

Working Conditions: The WG–14 Instrument Maker frequently works inside and occasionally in outside areas. He is exposed to the possibility of cuts, bruises, scrapes, burns, or broken bones, and may be exposed to fumes, radiation, or unstable biological conditions. The tasks may involve discomfort while wearing helmets, aprons, gloves, safety glasses, hard hats, and other protective equipment as required by changing assignments.

General: The WG–15 Instrument Maker plans, lays out, modifies, and fabricates instruments which are more complex than those described at the WG–14 level. In contrast to the WG–14 Instrument Maker who makes devices that require skill and knowledge in a single, broad occupational area, the WG–15 Instrument Maker uses skill and knowledge of a combination of occupational areas such as electromechanical, or photo-optics combined with pneumatics and hydraulics. The WG–15 Instrument Maker is responsible for all the planning and manufacturing processes whether he personally performs them or is assisted by other craftsmen. Responsibility for all of the planning and manufacturing processes is also typical of the WG–14 level but because the requirement to use skill and knowledge of a wider variety and greater number of work processes, the WG–15 Instrument Maker encounters and solves more problems that require him to make additional judgments and decisions.

Skill and Knowledge: The WG–15 Instrument Maker must know how to plan and lay out unique and novel instruments and to perform, or direct the fabrication processes for the complete instrument. The instruments he makes represent a broad knowledge of several occupational categories and a variety of design characteristics. For example, based on a thorough knowledge of their characteristics, the WG–15 Instrument Maker develops the circuitry and determines the need for a variety of electrical and electronic components. After personally fabricating the metal components, he assemblies, arranges, mounts, wires the components, accomplishes precision fitting, and aligns and tests the complete assembly. Given the same assignment, another WG–15 Instrument Maker would plan and fabricate the electrical and electronic components and plan and direct the fabrication of the metal components. In either example, the WG–15 Instrument Maker is responsible for all components of the complete electromechanical instrument, its accuracy, and operating quality.

Other typical instruments that are assigned to the WG–15 Instrument Maker require skill in working materials such as steel, aluminum, copper, fiberglass, plastics, ceramics, rubber, fiber phenolics, and in addition, soldering and welding, cable splicing, harnessing, isolation and miniaturization techniques. As another example, the kinds of instruments assigned to the WG–15 Instrument Maker require the understanding of optical system design and its related

mechanical design principles for holding and moving optical components without deformation or misalignment and the ability to manufacture, fit, and align all components by machining and assembling components of the complete instrument to extremely close fits and tolerances.

The WG–15 Instrument Maker is skilled in the operation of more of a variety of tools and equipment than the WG–14 Instrument Maker because he uses skills in broader occupational areas. For example, he plans and makes special jigs, fixtures, and tools to assist in the machining processes and, on the same project, he uses a variety of electronic equipment such as volt-ohm meters, frequency meters, audio-oscillators, autocollimators, alignment telescopes, and other similar equipment for testing components of the more complicated instruments. The knowledge of shop mathematics that the WG–15 Instrument Maker uses is more extensive than that used by the WG–14 Instrument Maker because the design characteristics of the instruments to be manufactured present problems in unrelated trade areas. For example, an instrument with electromechanical features requires the calculation of various angles and planes and unusual contours and shapes to plan and lay out the mechanical components and, in addition, the calculation of load, resistance, capacitance voltage, and other electronic mathematical problems.

Responsibility: The supervisor makes general assignments without detailed instruction on projects typically associated with the development of unique and complex research instruments which are without precedent or closely related work. Guidelines provided consist mainly of oral information related to basic instrument requirements and environmental conditions.

The WG–15 Instrument Maker makes unreviewed trade judgments and decisions on how the instrument will be fabricated, including determinations of precise specifications required to achieve the final operating characteristics requested by scientists and engineers. Both researchers and the supervisor depend on the broad experience, originality, and ingenuity of the WG–15 Instrument Maker for the solution of fabrication, practical design, assembly, and installation problems. The WG–15 Instrument Maker may consult with professional instrumentation engineers, and electronic specialists on unusually complex and difficult problems which cannot be solved through practical design or fabrication techniques.

The supervisor reviews work through periodic progress reports from the instrument maker and through discussions with technical and professional personnel with whom the instrument maker is working.

The work at the WG–15 level is more responsible than at the WG–14 level because the more complicated instruments require more judgments and decisions concerning a greater variety of alternative methods, materials, and work sequences, and planning, assembling, and testing techniques.

Physical Effort: Physical effort at this grade-level is the same as that described at the WG–14 level.

Working Conditions: Working conditions at this grade-level are the same as those described at the WG–14 level.

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U.S. Government Printing Office, Washington, D.C. 20402
Price: 25 cents, domestic postpaid; 15 cents, GPO Bookstore
Stock No. 0600–00699

U.S. GOVERNMENT PRINTING OFFICE : 1973—O-497-441